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AN OVERVIEW OF AERODYNAMIC RESEARCH AND TECHNOLOGY REQUIREMENTS AS RELATED TO SOME MILITARY NEEDS

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SUMMARY

Based on unclassified sources, a general review is presented of some military needs in light of the perceived U.S.S.R. doctrine, force balances, inventory growth, inventory items, and current actions. The Soviets appear to be attempting to increase their sphere of influence through economic and political control as well as possible military control of land, sea, air, and space. To offset such possibilities, certain areas of deterrent needs that the Western World might pursue are suggested. Particular emphasis is placed on the role of research and technology related to aerospace systems as part of the deterrent needs.

INTRODUCTION

The social and economic programs of the Soviet Union have been accompanied by the buildup of a powerful military force. A clear understanding of this force is essential to the shaping of the free world response. This paper does not represent a NASA view but examines the actions of the Soviet Union in light of the Department of Defense document "Soviet Military Power." Other sources of information drawn on are listed in the bibliography. The role of research and technology related primarily to aerodynamic systems as part of a deterrent force to offset potential Soviet capabilities will be considered.

THE SOVIET VIEW

According to the Soviet view, world leadership and technological superiority are directly proportional. It is clear that among the important Soviet stratagems to gain their achievement of world science leadership has been to invest heavily in the training and development of professional manpower, to plan effectively for the use of the resources available, and to avail themselves of external technology by any means possible.

Some of the major Soviet thrusts are:

- Homeland defense - long stated as the reason for the Soviet military buildup, continues to grow as a land- and air-based system but is also expanding to include sea-based systems and perhaps space systems.

- Multiple projection of power - new items of military equipment now indicate more than homeland defense by providing the potential to project power by air and sea to points far distant from the homeland.

- Rapid deployment and mobility - a theme substantiated by the kind of military equipment being fielded.

- Increased amphibious capability marked by new classes of ships, helicopters, and surface-effects landing craft--a force not generally thought of as defensive but rather for offensive power projection.

- Improved logistic support with a variety of aircraft and helicopter types (including the assets of Aeroflot). The Soviet merchant marine is also among the world's largest ocean-going fleets.

- Expansion is a practice of gaining a measure of control into other territory (Afghanistan, Cuba) without given rise to other than a passive response from the free world.

- Sea power is one of the most rapidly growing components of the Soviet armed forces having changed over the past two decades from a force of little significance to perhaps the world's most powerful Navy. Soviet doctrine states that the primary missions of the Navy are to display the capability of launching nuclear missile strikes, conducting Navy air antishipping strikes, conducting sea battles to gain sea control, and to assist ground forces in operation. With the advent of ever-increasing numbers of vessels (including nuclear-powered), and with the availability of ports in strategic worldwide locations, the Soviet Navy, for some time, has been spending more ship-days out-of-area than has the U.S. Navy.

Such an array of Soviet thrusts could lead to a worldwide offensive capability for the U.S.S.R. with the ability to control theater warfare remote from the homeland and to operate with versatility and mobility in quantity. Soviet systems that are already in evidence or that might reasonably be expected in order to add credence to the apparent thrusts include:

- Long-range high-speed interceptor as a defense against air-launched cruise missile carriers and possibly as an additional antishipping system.

- Long-range air-to-air missiles to fulfill the interceptor air intercept role.

- Long-range air-to-surface missiles to add to antishipping capability or to possibly support ground attack.

- Improved V/STOL for Navy shipboard use or restricted air base use.

- Navy carrier aircraft to accompany large carriers currently under construction.

- WIG patrol - wing-in-ground-effect vehicle to provide long-endurance, large-area sea patrol missions for ASW. Also, a possible logistic vehicle.

- Long-range manned bomber for strategic strikes or added antishipping capability. A prototype (RAM P, Blackjack) was discovered in November 1981.

- Enhanced space systems for both the further use of space and the denial of the use of space to others.

- Advanced Naval systems to provide power projection to any point on the globe and attempt to control the sea lanes. One of the goals of sea-land control would be to shut off the flow of critical raw materials.

Possible Problem Areas

Strategic penetrability.- As illustrated in figure 1, strategic penetration with current manned systems could pose some problem areas. Although the U.S. had a

numerically superior bomber force at the end of 1980, the number of U.S.S.R. interceptor aircraft and land-based SAM launchers could make penetration difficult. The possible addition of sea-based SAM launchers on Soviet ships such as the Kirov-class cruiser could only compound the problem. Soviet bombers, although less in numbers, would face a somewhat limited defensive system. The inclusion of Backfire bombers (not considered as part of the strategic bomber force) would further enhance the Soviet penetrating capability.

Kirov cruiser.- The Kirov-class cruiser (fig. 2) is potentially capable of a variety of missions including possible use as a sea-based SAM launcher. Among the array of armament are twelve vertical launchers which may contain a Navy version of the SA-10 strategic missile (SA-N-6). The SA-10 is thought to be about a M = 6 missile for rapid intercept of cruise missiles at low to medium altitudes. Such a defensive sea-based system would be an effective way to extend the protection against long-range cruise missiles to substantial distances from the homeland and at ranges up to about forty miles from the launcher.

Naval balance.- One measure of Naval balance is depicted in figure 3 based on available data through 1980. The number of major surface ships as well as submarines is somewhat greater for the U.S.S.R. than that for the U.S. The U.S. does, of course, have a numerical lead in aircraft carriers at the present time and, consequently a lead in ship-based aircraft. However, the U.S.S.R. has a substantial numerical lead in shore-based Naval aircraft, the bulk of which are dedicated to antishipping. The U.S.S.R. also has a notable lead in antishipping missiles including numbers of types, warhead, size, range, and speed.

U.S.S.R. Capability Summary

Soviet commitment to military equipment has led to:

- Numerical superiority (and possible narrowing of technology gap).
- Potential for the control of ground, air, sea, space, and strategic materials.
- Potentially increased adventurism or boldness.
- Possible denial of oversea basing to the U.S.

If it became necessary to conduct military operations from the continental U.S., the distances involved become significant--on the order of 4000-8000 miles (fig. 4). For a creditable deterrent force, capable of reaching military targets within the Soviet Union, for example, ranges on the order of 1000 to 2500 miles would be required, even from the Soviet border, in order to reach the majority of the targets (fig. 5).

WESTERN RESPONSE TO SOVIET CAPABILITY

Needs Summary

Consideration of the potential impact of Soviet capability on the free world leads to some specific needs. These needs include:

- Creditable deterrent - meaning the perceived, if not the actual, ability to generate a response such that a potential attacker would choose not to attack.

- Rapid, flexible, worldwide response - meaning the ability to respond essentially instantaneoulsy to any point on the globe.

- Meaningful payload - meaning that the fractional weight devoted to payload should be enough to provide damaging lethality in the case of munitions, or in the case of logistics, sufficient supplies to sustain a protracted presence if need be.

- Penetrability - a challenging area for innovative thought in view of the potential defense.

- Fleet defense - to provide for the survival of the fleet against a steadily improving Soviet force.

- CONUS defense - to reequip an almost nonexistent homeland defensive force to offset a steadily growing U.S.S.R. capability to penetrate U.S. territory.

- Antishipping - sufficient to incapacitate a rapidly growing Soviet Naval force capable of sea contol.

- Space control - to provide the ability to maintain operable systems in space and to eliminate hostile space systems.

Vehicle Requirements

Vehicle requirements that are dictated by the apparent needs include:

- Airplane/missile mix
- Long range
- High speed
- Volumetric efficiency
- Basing flexibility
- Endurance
- Survivability
- Affordability

Vehicle Categories

Certain vehicle categories that warrant a new look can be determined from the needs and requirements. These categories include:

AIRPLANES

- Long Range Combat
  - Penetrator
  - Cruise Missile Carrier
  - Interceptor
  - Logistic/Recce/Tanker
- Advanced Fighters
  - Strike/Attack (Sea/Land Based)
  - Sea Based Fleet Defense
  - Tactical
- Advanced V/STOL
- Helicopter
  - Heavy Lift
  - Attack

MISSILES

- Strategic Cruise
  - Antishipping
  - Antisubmarine
  - Penetrator/Strike
- Tactical
  - Air Defense (Fleet/Ground)
  - Ground Support
  - Air Superiority
  - Defense Suppression
  - ABM

SPACE

- Single Stage to Orbit
  - Space Station
  - Anti-Satellite
  - Satellite

OTHER

- WIG
- SEV
- Air cushion

Missile types such as strategic cruise missiles for antishipping, antisubmarine, and penetration/strike and advanced tactical misiles for air defense (both land and sea), ground support, defense suppression, air superiority, and antiballistic missile (both strategic and tactical battlefield ballistic missiles) should have increased range, speed, lethality, and launch flexibility compared to current systems.

Long range combat airplanes for use in penetration, antishipping, intercept, and various support functions such as logistics, reconnaissance, and tanker may be relatively large. In some cases, these airplanes could exceed the million-pound weight category. Fighter aircraft include strike/attack, both sea- and land-based, fleet defense, and tactical air superiority/ground support types and would require better range, speed, maneuver, and basing flexibility than current fighters. Other airplane types include advanced V/STOL and helicopter.

Other vehicle types that merit consideration range from various space systems to near-earth specialized systems such as wing-in-ground effect (WIG), surface effect vehicles (SEV), or air cushion vehicles.

WEAPONS SYSTEM CONSIDERATIONS

In addressing the potential Soviet capability, a variety of needs, requirements, and vehicle types have been suggested. In many cases, a missile or a missile/airplane combination seems appropriate as a means of meeting the needs. While it is not the purpose of this paper to define operational tactics, an attempt will be made to define the rationale for the use of some airplane and missile systems. A review of the vehicle requirements previously listed indicates that many of the requirements could be favorably influenced by some combinations of features that are inherent to different systems. A basic consideration to remember is that a missile is expendable while a manned vehicle is not. This consideration leads to some missions where maximum use should be made of missiles or of missile/airplane, missile/ship combinations.

Affordability.- Missiles, by the nature of their throw-away role, should be conceived with as little complexity as possible. Innovation and simplicity need not be in opposition. By exercising some thought, relatively simple designs might be conceived that could perform difficult missions. In areas of materials, structures, propulsion, manufacturing techniques, and undoubtedly many others, certain simplistic approaches could be pursued because of the expendable nature and relatively short life of a missile. In other words, designing to specific mission requirements without the constraints of man-rating or reusability could lead to reduced cost.

Survivability.- Missiles, without the constraints of man-rating, are readily adaptable to features conducive to survivability such as high-speed, small-size, high- and low-altitude options.

Long range/endurance.- Partly due to the one-way mission of a missile, the range can be maximized. In addition, through the use of various booster arrangements and through the packaging of more fuel (without man constraints), greater range and/or endurance is enhanced. In the case of airlaunch, the carrier aircraft should provide the maximum stand-off distance for launch.

Volumetric efficiency.- Lack of man constraints and such subsystems as might be required for vehicles that take off and return to land, the volume of a missile may be used more efficiently for fuel or ordinance that contribute more to the effectiveness of the system.

Strategic penetration.- Because of seemingly formidable defensive systems, a missile would appear to be a likely weapon for strategic penetration from the standpoint of survivability. Long-range capability, which is desirable for penetration, is more easily accomplished by a missile which needs to go only one way from a maximum stand-off launch position. In addition, high-speed capability at high altitude (and perhaps at low altitude) as well as smaller size for reduced detectability is more easily achieved with missile systems. Such systems obviously are not without problems not the least of which are target detection and terminal homing.

Tactical penetration.- Battlefield penetration against massed armor and troops both at relatively close ranges and at relatively long ranges are roles suitable for missiles. A possible concept, particularly for territory that is known to be occupied by unfriendly forces, could be an extremely high-speed, low-altitude, over-flight missile--on the order of $M = 2\text{-}4$ and altitudes measured in hundreds of feet. Defense against such a missile would be difficult. The warhead would be of a downward spray type of simple shapes (spherical) with perhaps no need for terminal guidance when used over known enemy territory. Such a system could also carry enhanced-radiation weapons. Structural considerations resulting from expected high temperatures and pressure could be partially offset for a throw-away missile by essentially designing to maintain system integrity only long enough to complete the mission.

Air defense.- Surface-to-air missile systems for various purposes including field army defense, fleet defense, and CONUS defense. Such systems must cover operational envelopes from very low altitudes to very high altitudes and from relatively short range to extremely long range. Rapid response is required which implies high speed and, perhaps, vertical launch, particularly for firing-on-the-move from ground or sea platforms. Thought should also be given to antiballistic missiles including tactical as well as strategic defense.

Air superiority.- Already an obvious role for missile systems but one that could benefit from longer range (over-the-horizon) capability, higher speeds, greater maneuverability, and improved carriage and launch. Attention should also be given to helicopter-launched systems.

Antishipping.- Considering the naval balance previously discussed, a need appears to exist for air- and surface-launched missiles dedicated to antiship and antisubmarine warfare. New systems should have large operational envelopes, high lethality, high speed, and improved carriage/storage and launch.

Logistic.- Aircraft that might be contemplated for performing logistic support may vary from one- to five-million pounds gross weight with payload fractions approaching 50 percent. Ranges on the order of 10- to 12-thousand miles would be of interest in carrying out missions from the continental U.S.

RESEARCH OPPORTUNITIES

The use of missiles and aircraft in ways just described offer some unique opportunities for research and development. These opportunities by discipline areas include:

Aerodynamics

- o Exploit interference flow fields
- o Blended shapes
- o Aerodynamic center management
- o Reduced control forces
- o Simple variable geometry
- o Propulsion integration
- o Vertical launch
- o Laminar-flow control

Propulsion

- o Multiple cycle
- o Consumable motors
- o Smokeless propellants
- o Airbreathing concepts
- o Reduced fuel consumption
- o Higher temperature components
- o Turboprop
- o Digital controls
- o Alternate fuels

Structures

- o Composites
- o Net shapes
- o Light weight
- o High strength
- o Temperature tolerance
- o Manufacturing techniques
- o Producibility
- o Superplastic forming/diffusion bonding of titanium
- o New materials
- o Advanced metallics

Avionics

- o Distributed radar
- o Innovative sensors
- o Fiber optics
- o Microprocesing
- o Miniaturization
- o Flight controls
- o Innovative guidance

Others, of course, could be added but, needless to say, opportunities for research and development abound.

CONCLUDING REMARKS

It is hoped that this paper has, to some degree, provided a clearer understanding of Soviet military power and potential capability. With that understanding, it is possible to determine some of the needs for a free-world response and to explore the role of research and technology as part of a deterrent force.

Briefly, the concluding observations are:

- o The U.S.S.R. has developed a military capability that cannot be ignored.
- o As a result, a creditable deterrent force having a worldwide capability of rapid response would be desirable.
- o Use should be made of missiles and missile/launcher combinations for reasons related to penetrability, expendability, and affordability.
- o Airplanes with long range and large payloads are desirable.
- o Opportunities for innovative aerospace research and development abound.

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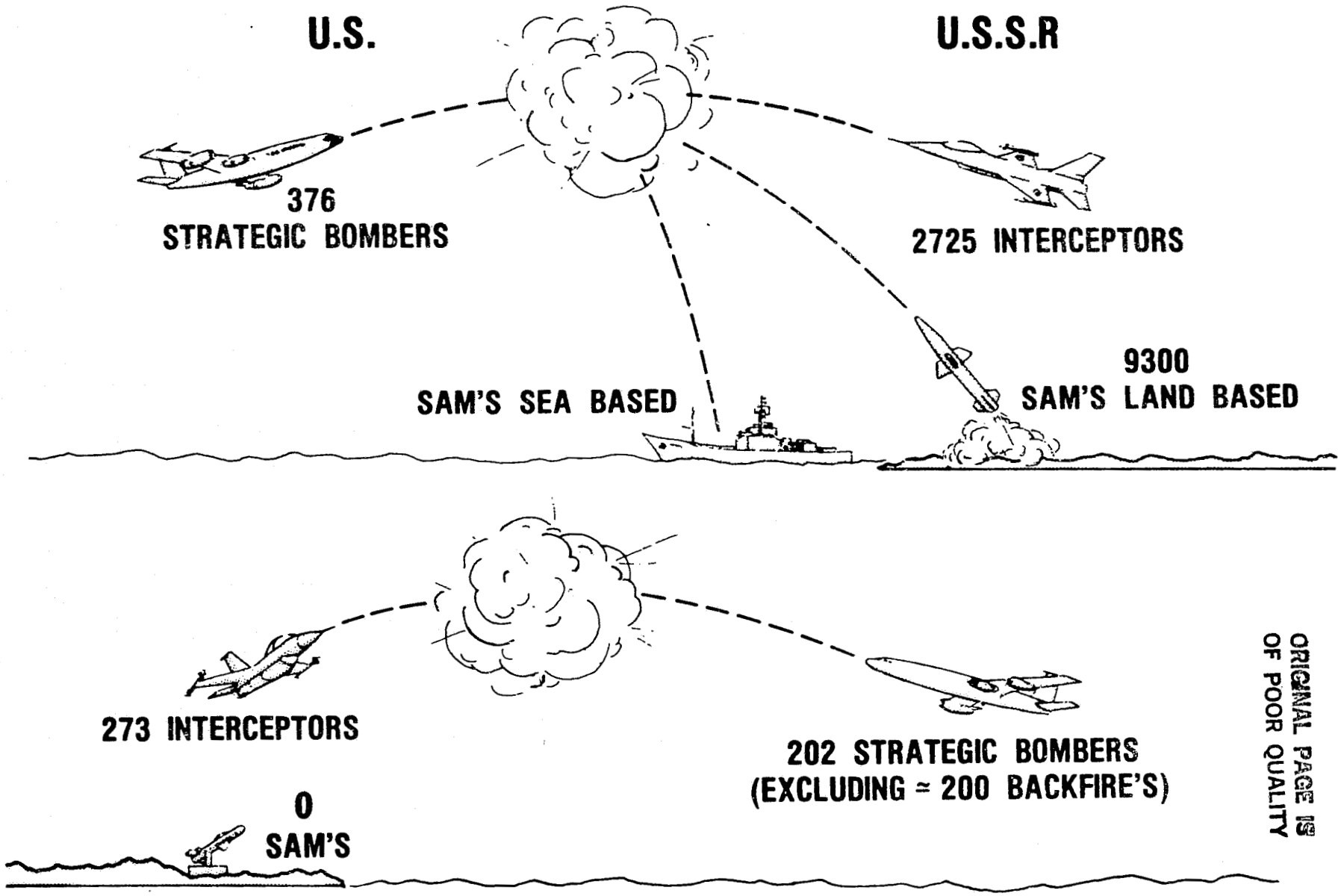

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Figure 1.- Strategic penetration with manned systems.

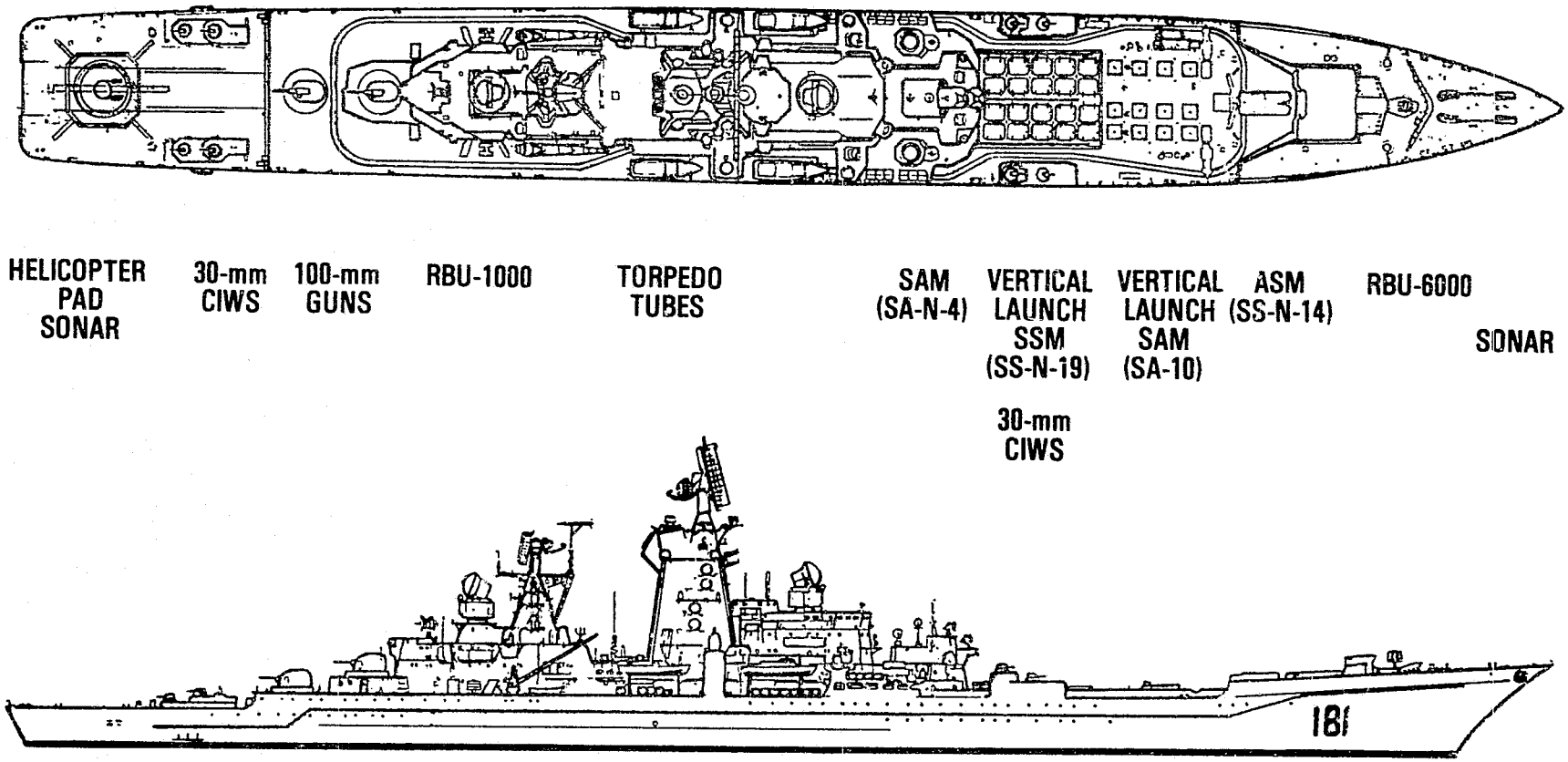

Figure 2.- Kirov cruiser armament.

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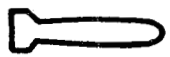
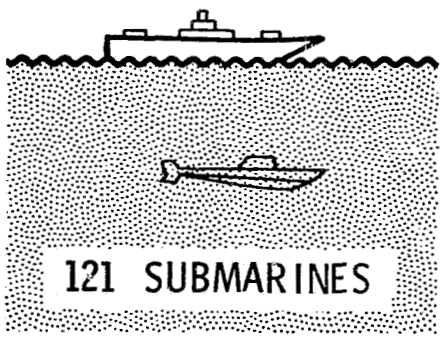
U. S.

ANTISHIPPING MISSILES



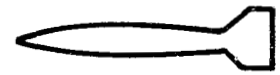
ONE TYPE
W. H. 500 lb
RANGE 35 n. mi. (SSM)
120 n. mi. (ASM)

200 MAJOR
SURFACE SHIPS



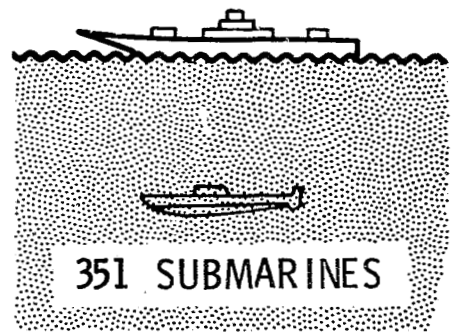
U. S. S. R.

ANTISHIPPING MISSILES



NINE TYPES
W. H. 1K TO 5K lb
RANGE 30 n. mi. TO
350 + n. mi.
SSM AND ASM

275 MAJOR
SURFACE SHIPS



MESSAGE: IMPROVE ANTISHIPPING SYSTEMS

Figure 3.- The naval balance.

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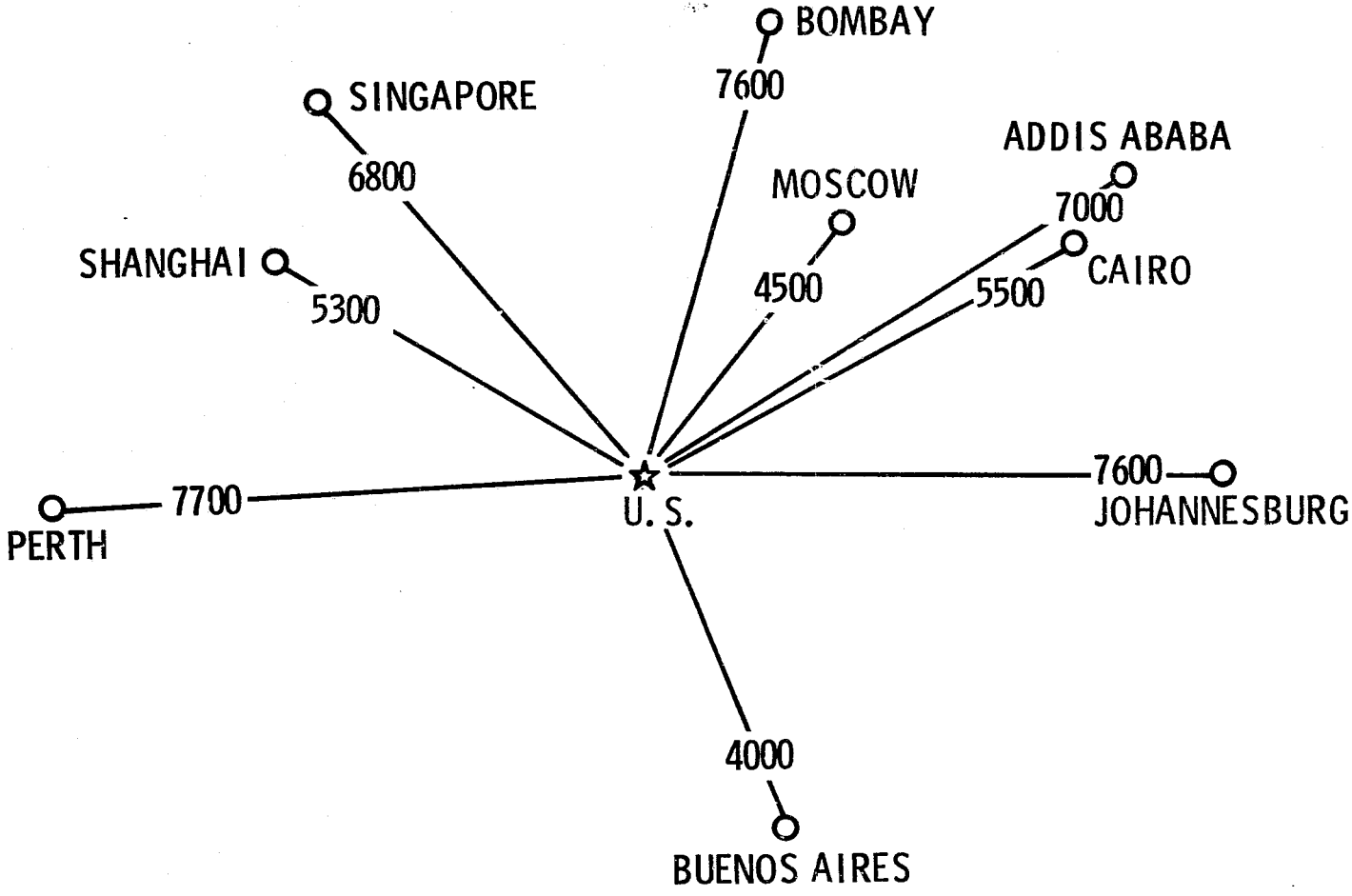

Figure 4.- Worldwide air distances from the U.S.

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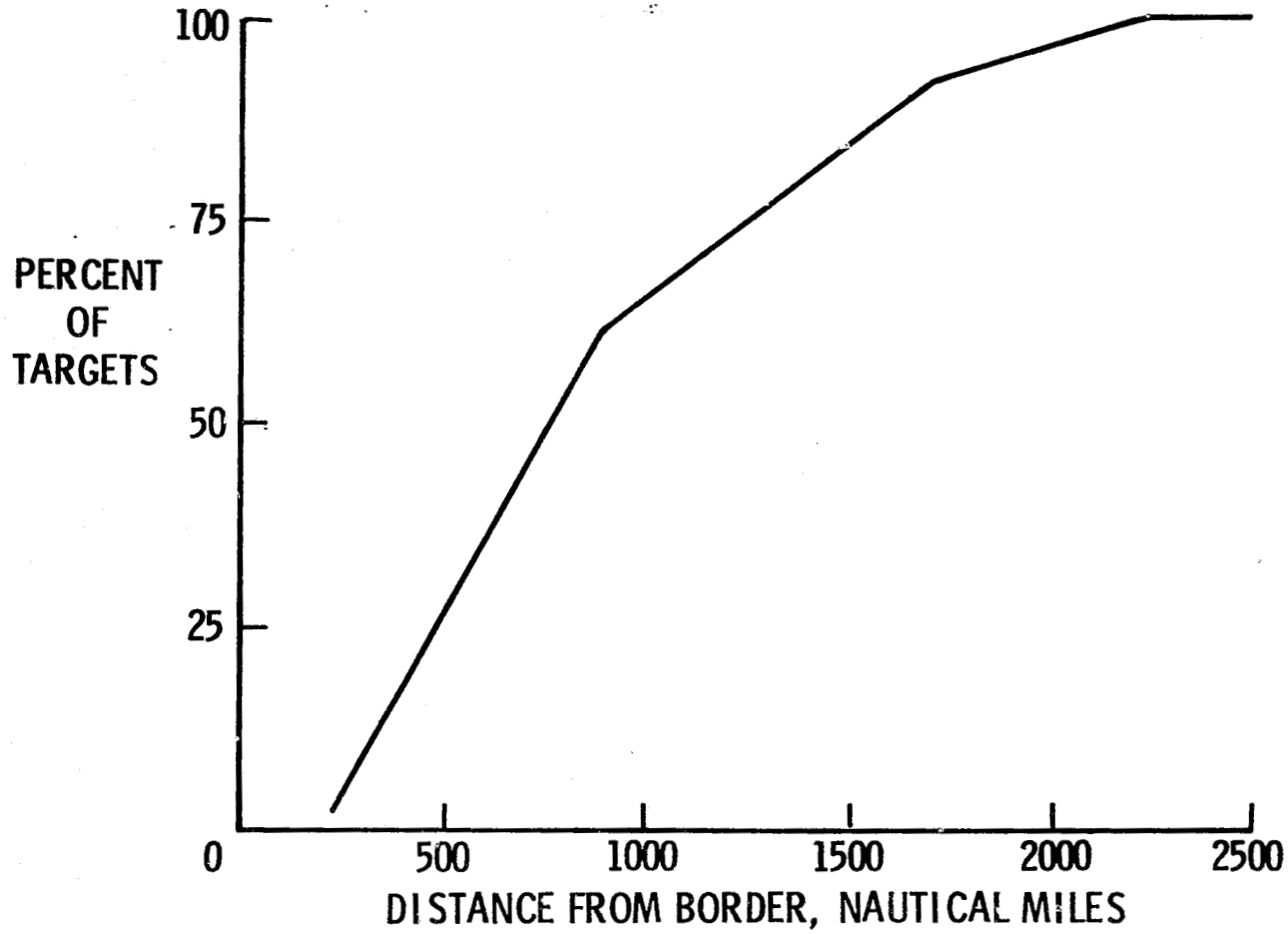

Figure 5.- Distance to principle targets from Soviet border.

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